# FINAL REPORT
# FOUNDATION INVESTIGATIONS
# EAST MARGINAL WAY PUMP STATION (B2)
# SEATTLE, WASHINGTON

MR 8238

METROPOLITAN ENGINEERS
410 West Harrison Street
Seattle 99, Washington

November 9, 1962

Mr. Frank J. Kersnar
Metropolitan Engineers
410 West Harrison Street
Seattle 99, Washington



W210B-19

FINAL REPORT
FOUNDATION INVESTIGATION
EAST MARGINAL WAY PUMP STATION (B2)
SEATTLE, WASHINGTON

INTRODUCTION

This report summarizes the foundation recommendations made to our design engineers during the final design of the proposed pump station. The 32-foot O.D. structure will be located on the west side of East Marginal Way as shown on the Plot Plan, sheet 1. The ground floor is planned at elevation 114* with the pump room floor at elevation 91 and a tremie seal extending to elevation 78. In addition, this facility includes about 30 feet of 60-inch influent sewer entering the station at elevation 93, three 24-inch effluent force mains at about elevation 109, and an effluent junction structure at roughly elevation 106. The existing ground surface varies from elevation 107 to elevation 113 and will require filling to about elevation 114.

FIELD EXPLORATIONS AND LABORATORY TESTING

The subsurface conditions were explored by the drilling of two test borings with cable-tool drilling equipment to depths of 59 feet and 65 feet at the locations shown on the Plot Plan. The soils encountered were logged by our soils engineer and representative undisturbed samples were secured for visual examination and laboratory testing. The soils encountered are shown graphically on the boring logs on sheet 3. Following the drilling of these borings, two well points were installed at selected elevations and the borings backfilled. Because of the proximity to the Duwamish River, water level readings in the well points were taken during a tidal cycle to observe the effect of tidal fluctuation upon the ground water. During this same period, the tidal fluctuation of the river level was also observed in nearby slip no. 4. This data is presented on sheet 4. Natural in-place densities and moisture contents of the representative samples were determined and the test results are shown at the left of the respective boring logs. In addition, selected samples were subjected to a consolidation test, sieve analyses, and strain-controlled direct shear tests. The test results for the consolidation test and sieve analyses are shown on sheets 5 through 7. The direct shear test results, run at a strain rate of .01 inch per minute, were as follows:

*Elevation 100 = Mean Sea Level

| Sample | Axial Test Surcharge (psf) | Shear Strength (psf) Yield | Peak | Ultimate |
|---|---|---|---|---|
| B1 @ elev. 92 | 1400 | 350 | 850 | 850 |
| B1 @ elev. 78 | 2500 | 700 | 1800 | 1700 |
| B1 @ elev. 73 | 600 | 300 | 550 | 440 |

## SUBSURFACE CONDITIONS

Our borings disclosed that about 8 feet of loose fine to medium sand blanketed the site. Approximately 7 to 15 feet of soft compressible laminated silt and sandy silt underlay the surface layer and was in turn underlain by 7 to 17 feet of permeable loose to medium dense fine to medium sand. Between roughly elevation 80 and elevation 55, 20 to 25 feet of moderately soft to moderately firm interbedded or laminated silty fine sand and sandy silt was encountered and was underlain by generally fine sand to the depths explored.

As shown by the ground water data plot on sheet 4, the ground water level fluctuates with the river level and was observed to vary from elevation 99 to elevation 102. The ground water low and high varied from the low and high tide by 3 feet and 2 feet, respectively, with a time lag of approximately 2 hours. Therefore, the ground water conditions during construction should be predictable on the basis of river and tide stages.

## CONCLUSIONS AND RECOMMENDATIONS

On the basis of the subsurface conditions disclosed during this investigation, it is concluded that construction of the pump station is feasible at this location. Since the foundation loading of the completed station is approximately equal to the weight of the soils removed, special foundations are not necessary and the structure can be supported directly on the undisturbed underlying soils.

The caisson method of construction is recommended since it eliminates the need for a deep open excavation close to the railroad as well as the need for sustained dewatering which could cause settlement of adjacent utilities and structures. Further, the silty soils below elevation 80 would be difficult to dewater and would be easily disturbed if inadequately dewatered.

Compressible soils underlie the surface and some settlement will occur due to site filling. The amounts of settlement will vary with the method and sequence of construction of the various units. In order to minimize total and differential settlement, it is recommended that the caisson be sunk to final elevation, the tremie seal poured and the caisson dewatered prior to beginning other work. The 60-inch influent sewer should then be installed and backfilled - preferably without dewatering. After the construction of the influent sewer, the area fill can be placed and the effluent pipes and junction structure constructed.

Since the pump station walls are rigid, the at-rest soil pressure should be used for wall design. Further, because of the quick interrelation between ground water level and river stage, it is recommended that a flood stage ground water level of elevation 110 be used. Estimates of lateral wall pressures for various conditions were made and are shown on sheet 2.

Jetting may not be necessary during the sinking of the caisson, however, provisions should be made for its use if required. It is important that the jets be directed upward in order to destroy the skin friction and yet prevent the disturbance of the supporting soils below the final elevation. Further, the water level inside the caisson should be maintained higher than the exterior ground water (with due allowance for tidal effect) prior to pouring the tremie seal. This will prevent the formation of "quick" or "boil" conditions in the supporting soils caused by upward seepage into the interior of the caisson. River water could be pumped into the caisson for this purpose.

The area filling will cause some settlement of the underlying softer soils. The major portion will occur in the layers above the base of the station. It is estimated that settlement of the station itself due to filling will not exceed about 1/4 inch at the influent side and 3/4 to one inch at the effluent side. Additional amounts of settlement would occur if the area fill were in place before the area was dewatered during construction of the 60-inch influent sewer. Therefore, the area filling should be deferred until the influent sewer is installed and backfilled.

Approximately 3 to 4 inches of settlement is expected to occur at the level of the effluent units due to the area fill. Since 90 per cent of this settlement will take place within 30 to 45 days after filling, construction of the effluent force mains and junction structure at the end of this period would substantially reduce the settlement of these units. For this reason, it is recommended that construction of the effluent units be deferred until 45 days after fill placement. Work on the pump station equipment installation and superstructure can continue, of course, during this period.

METROPOLITAN ENGINEERS

Eugene R. McMaster

Eugene R. McMaster, P.E.
Chief Foundation Engineer

EUGENE R. McMASTER
STATE OF WASHINGTON
REGISTERED
PROFESSIONAL ENGINEER

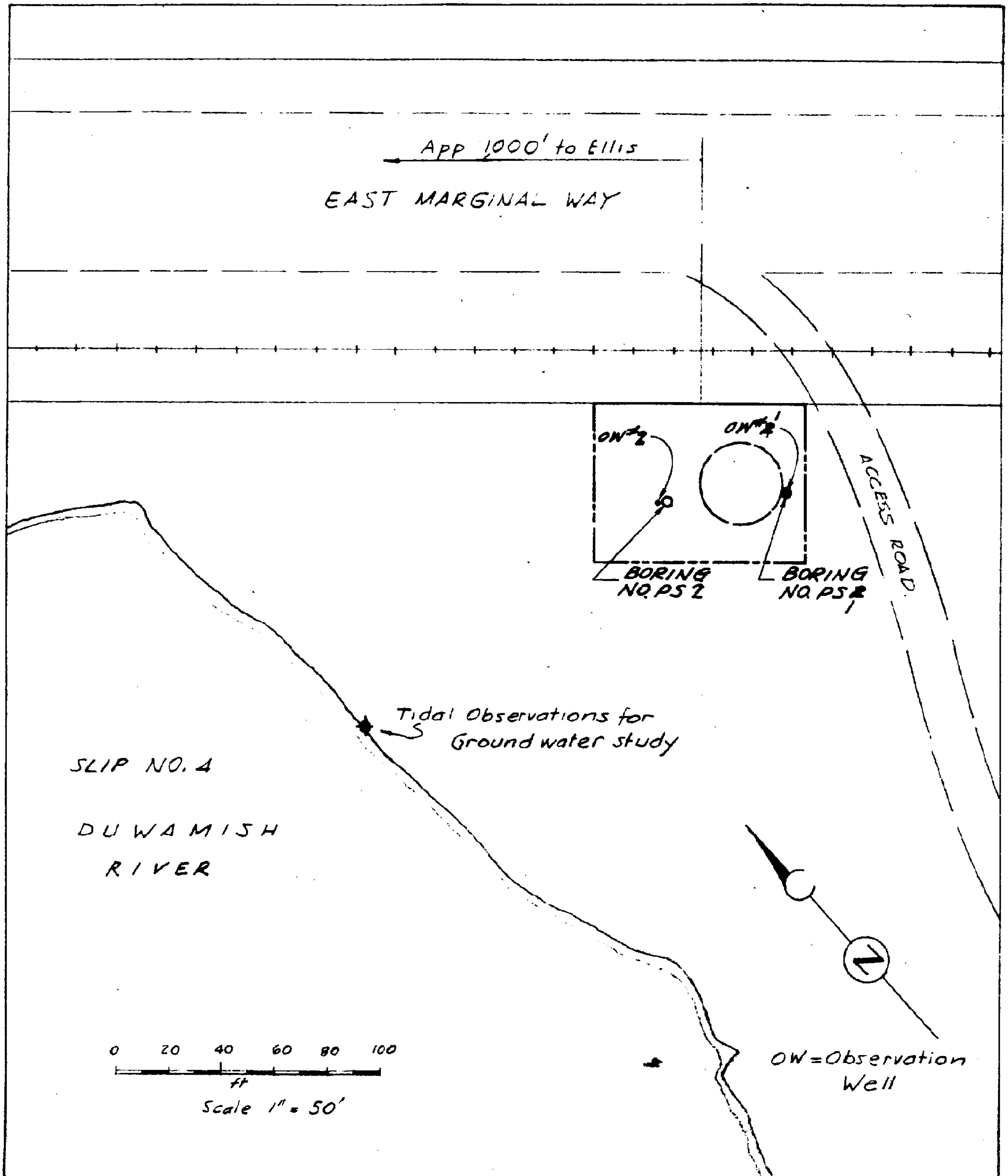
ERM:ab

Attachments:

- Sheet 1 - Plot Plan
- Sheet 2 - Lateral Wall Pressures
- Sheet 3 - Log of Borings
- Sheet 4 - Ground Water Data
- Sheet 5 - Consolidation Curve
- Sheet 6, 7 - Grain-Size Distribution

# CALCULATION SHEET

METROPOLITAN ENGINEERS
SEATTLE, WASHINGTON



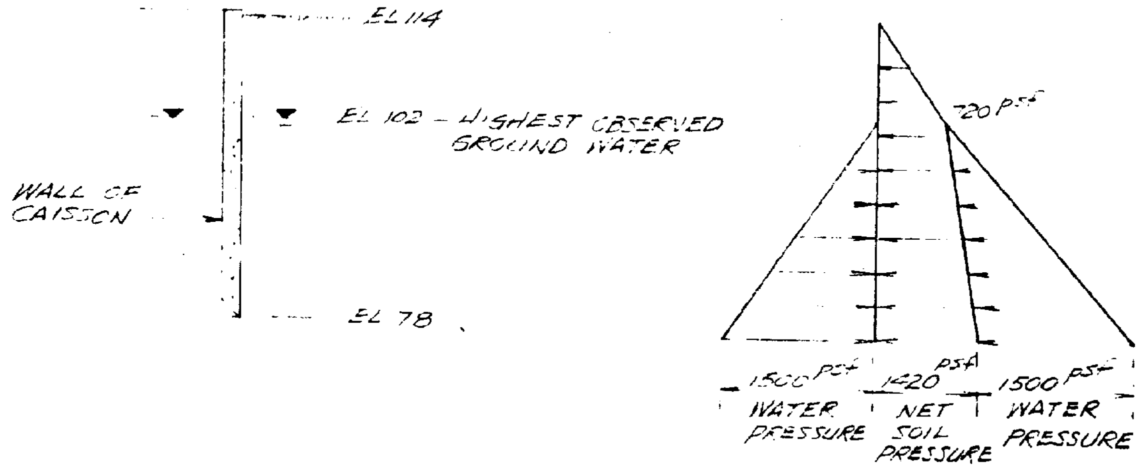

| DATE | BY | JOB NO. | TITLE | SHT. NO. |
|---|---|---|---|---|
| 5/25/61. | YBT | W210 8 | PLOT PLAN | 1 |

# CALCULATION SHEET

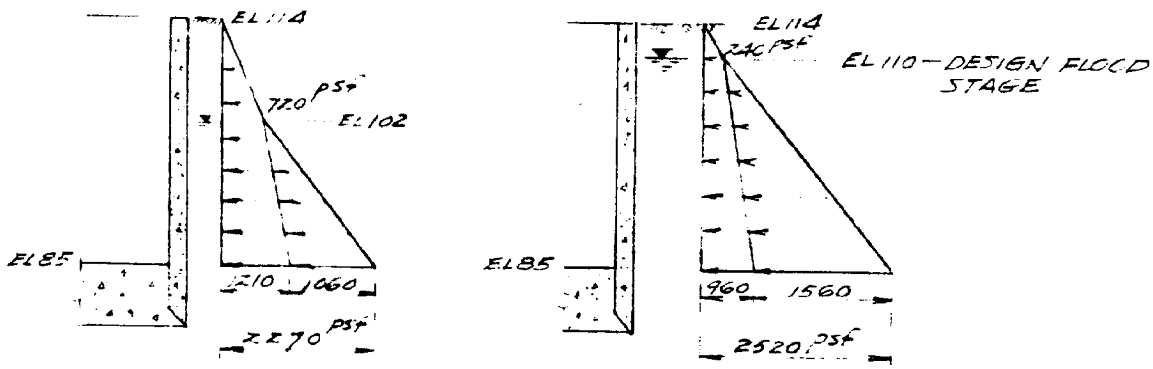
**METROPOLITAN ENGINEERS**
**SEATTLE, WASHINGTON**

## LATERAL WALL PRESSURE

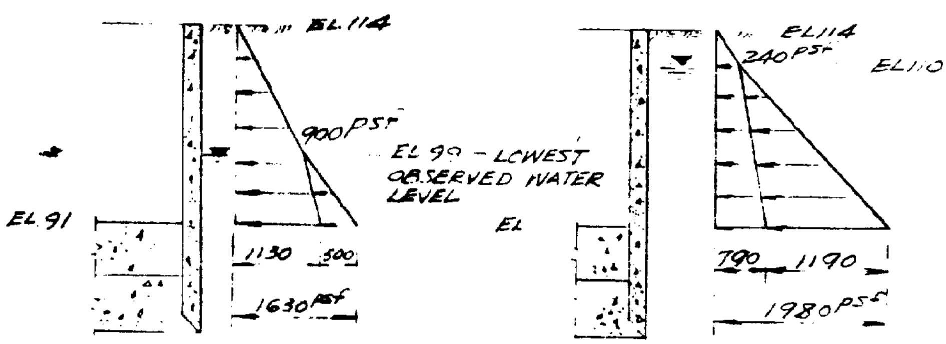
(A) DURING CONSTRUCTION. CAISSON IN PLACE, BEFORE DEWATERING



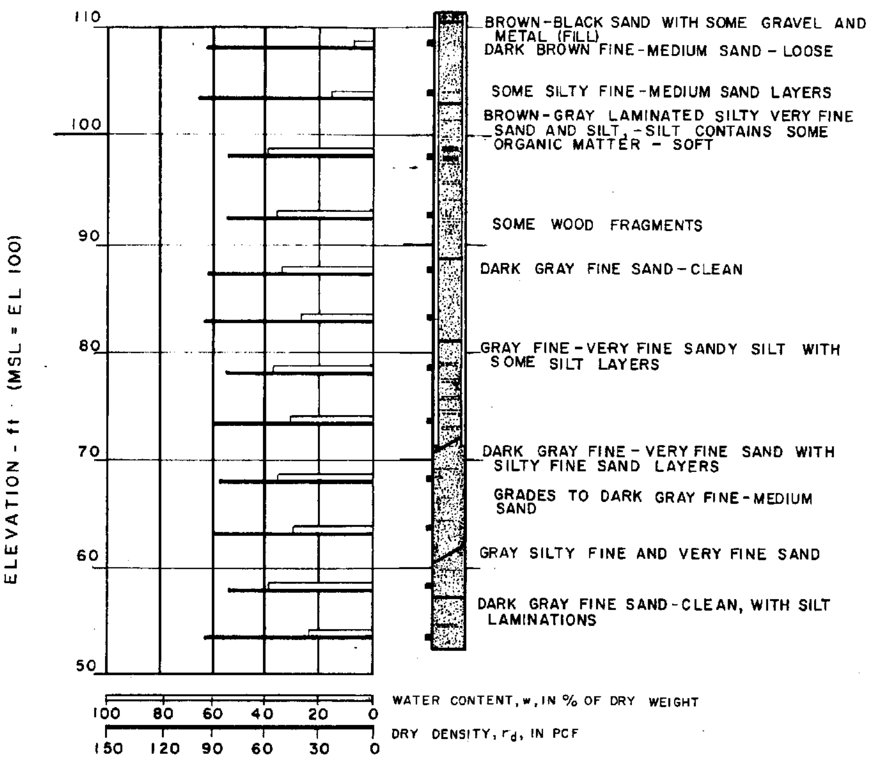

(B) DURING CONSTRUCTION. TREMIE SEAL IN PLACE. AFTER DEWATERING




(C) AFTER CONSTRUCTION

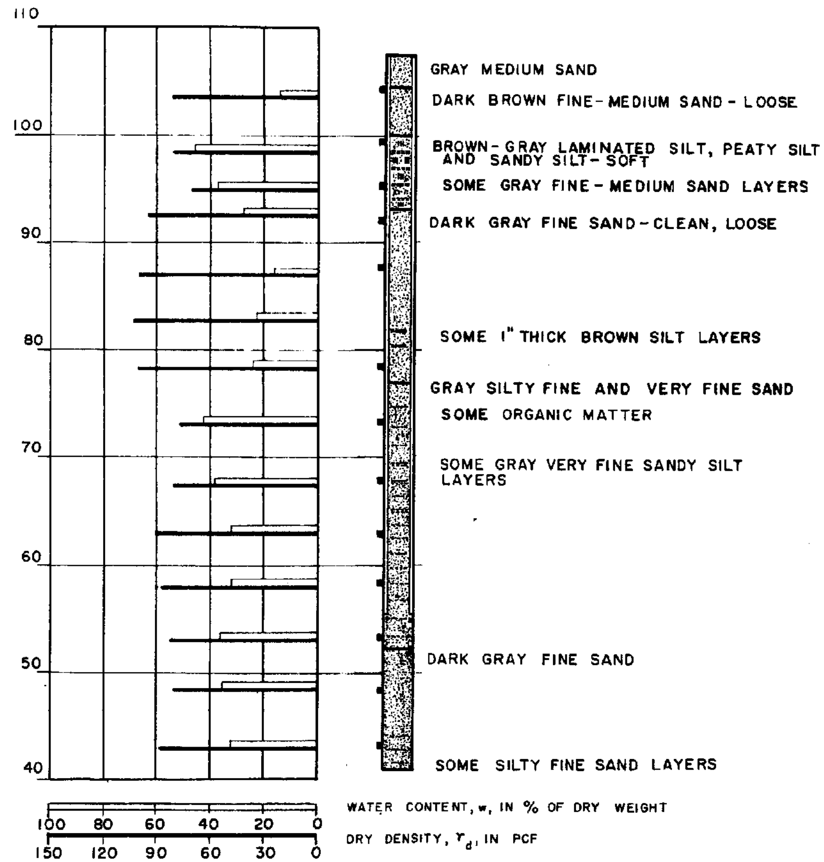



| DATE | BY | JOB NO. | TITLE | SHT. NO. |
|---|---|---|---|---|
| 11-9-62 | CHW | W210.B | LATERAL WALL PRESSURE | 2 |



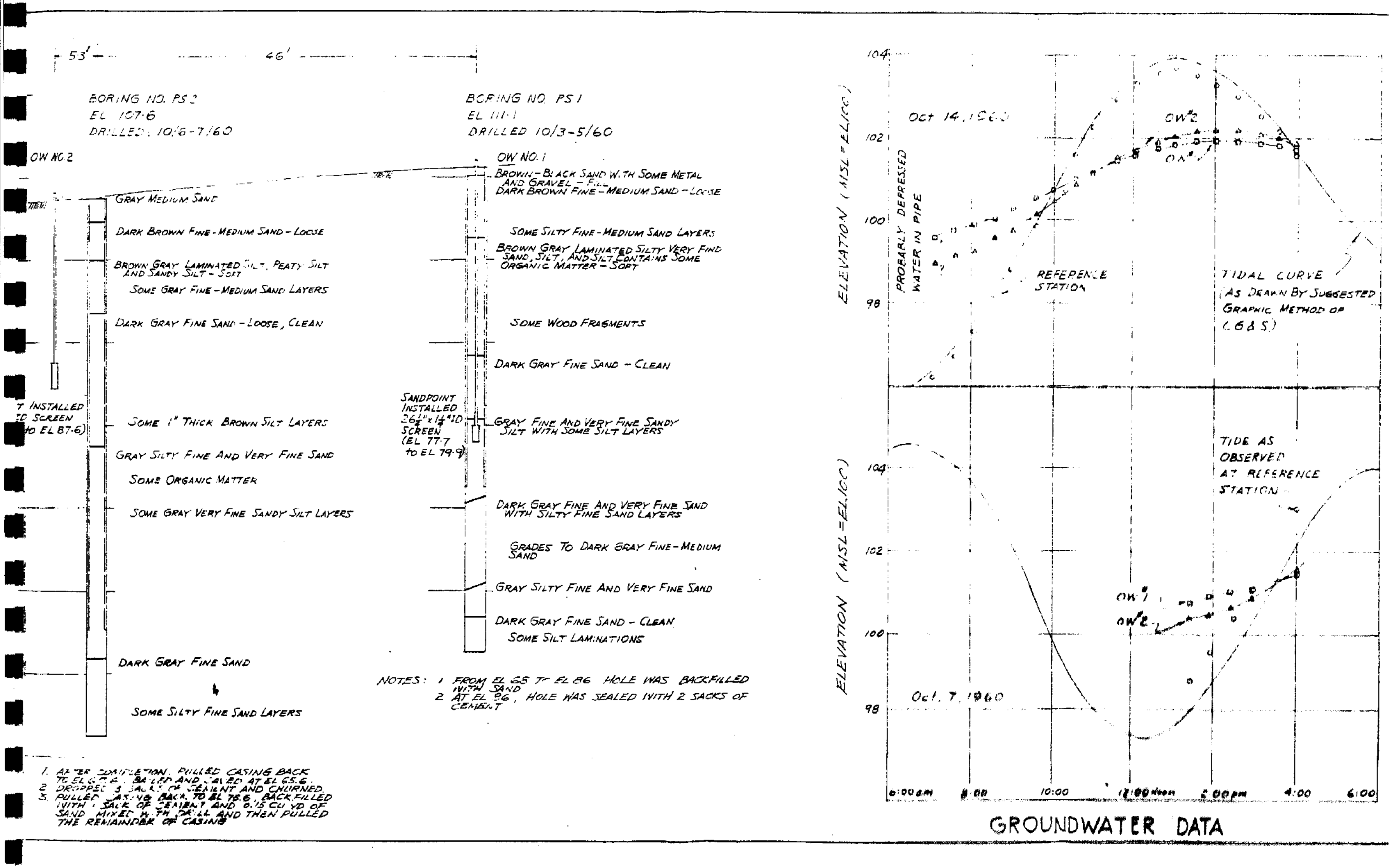

■ SAMPLED WITH $2\frac{1}{2}$" ID SPLIT-BARREL DRIVE SAMPLER

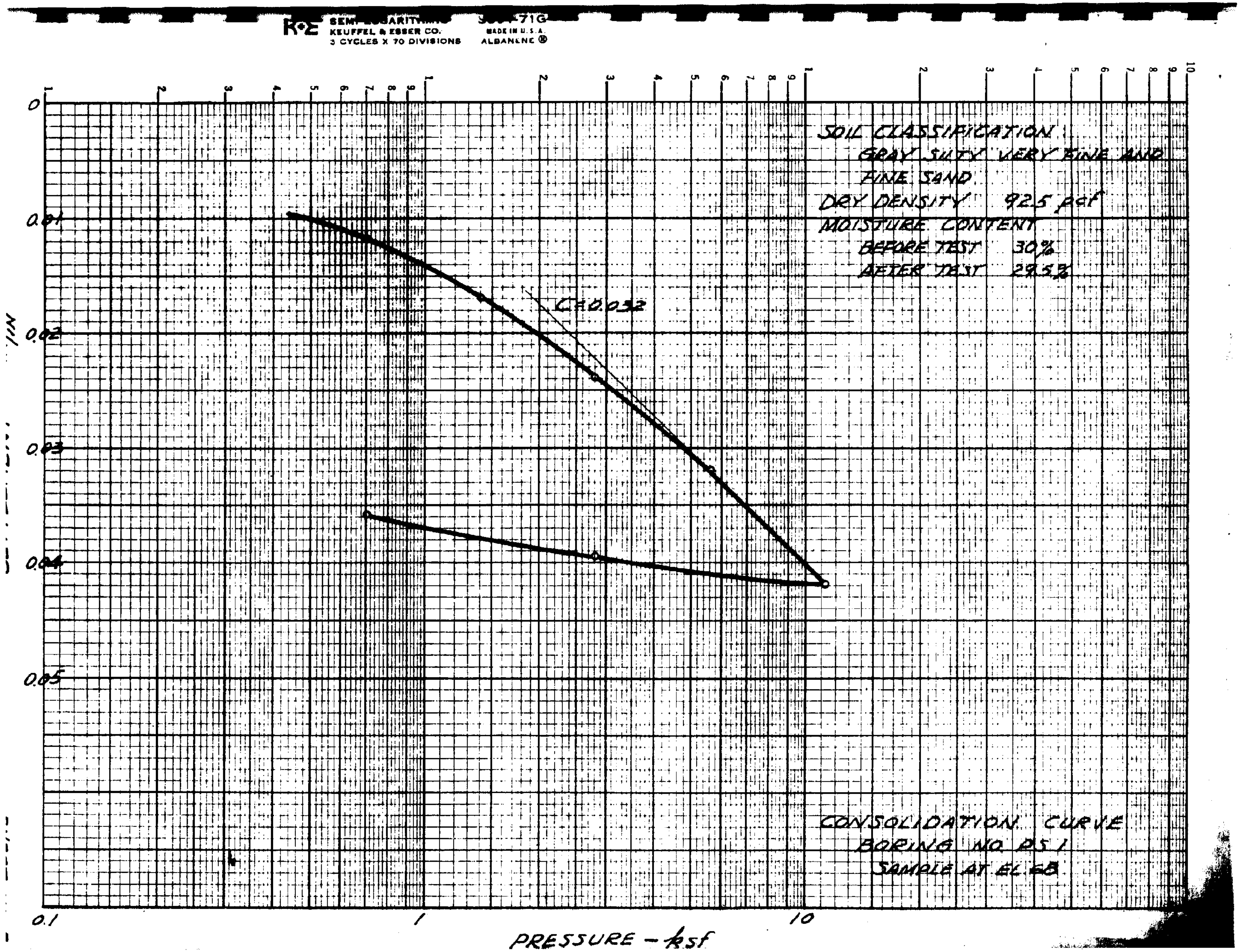
WATER LEVEL (SEE SHEET No 3)




## LOG OF BORINGS

SHEET NO. 3


53'
46'
BORING NO. PS 2
EL 107.6
DRILLED 10/6-7/60
BORING NO. PS 1
EL 111.1
DRILLED 10/3-5/60
OW NO. 2
OW NO. 1
GRAY MEDIUM SAND
DARK BROWN FINE-MEDIUM SAND - LOOSE
BROWN GRAY LAMINATED SILT, PEATY SILT AND SANDY SILT - SOFT
SOME GRAY FINE-MEDIUM SAND LAYERS
DARK GRAY FINE SAND - LOOSE, CLEAN
SOME 1" THICK BROWN SILT LAYERS
GRAY SILTY FINE AND VERY FINE SAND
SOME ORGANIC MATTER
SOME GRAY VERY FINE SANDY SILT LAYERS
DARK GRAY FINE SAND
SOME SILTY FINE SAND LAYERS
1. AFTER COMPLETION, PULLED CASING BACK TO EL 67.6. BAILED AND CAVED AT EL 65.6.
2. DROPPED 3 SACKS OF CEMENT AND CHURNED.
3. PULLED CASING BACK TO EL 75.6, BACKFILLED WITH 1 SACK OF CEMENT AND 0.15 CU YD OF SAND MIXED WITH DRILL AND THEN PULLED THE REMAINDER OF CASING
BROWN-BLACK SAND WITH SOME METAL AND GRAVEL - FILL
DARK BROWN FINE-MEDIUM SAND - LOOSE
SOME SILTY FINE-MEDIUM SAND LAYERS
BROWN GRAY LAMINATED SILTY VERY FIND SAND, SILT, AND SILT CONTAINS SOME ORGANIC MATTER - SOFT
SOME WOOD FRAGMENTS
DARK GRAY FINE SAND - CLEAN
SANDPOINT INSTALLED 26 1/4" x 1 1/4" ID SCREEN (EL 77.7 to EL 79.9)
GRAY FINE AND VERY FINE SANDY SILT WITH SOME SILT LAYERS
DARK GRAY FINE AND VERY FINE SAND WITH SILTY FINE SAND LAYERS
GRADES TO DARK GRAY FINE-MEDIUM SAND
GRAY SILTY FINE AND VERY FINE SAND
DARK GRAY FINE SAND - CLEAN
SOME SILT LAMINATIONS
NOTES: 1 FROM EL 65 TO EL 86 HOLE WAS BACKFILLED WITH SAND
2 AT EL 86, HOLE WAS SEALED WITH 2 SACKS OF CEMENT
Oct 14, 1960
OW 2
OW 1
PROBABLY DEPRESSED WATER IN PIPE
REFERENCE STATION
TIDAL CURVE (AS DRAWN BY SUGGESTED GRAPHIC METHOD OF C.G.&S.)
ELEVATION (MSL = EL 100)
104
102
100
98
TIDE AS OBSERVED AT REFERENCE STATION
OW 1
OW 2
Oct. 7, 1960
6:00 a.m
8:00
10:00
12:00 noon
2:00 pm
4:00
6:00
GROUNDWATER DATA




KCSlip4 53008

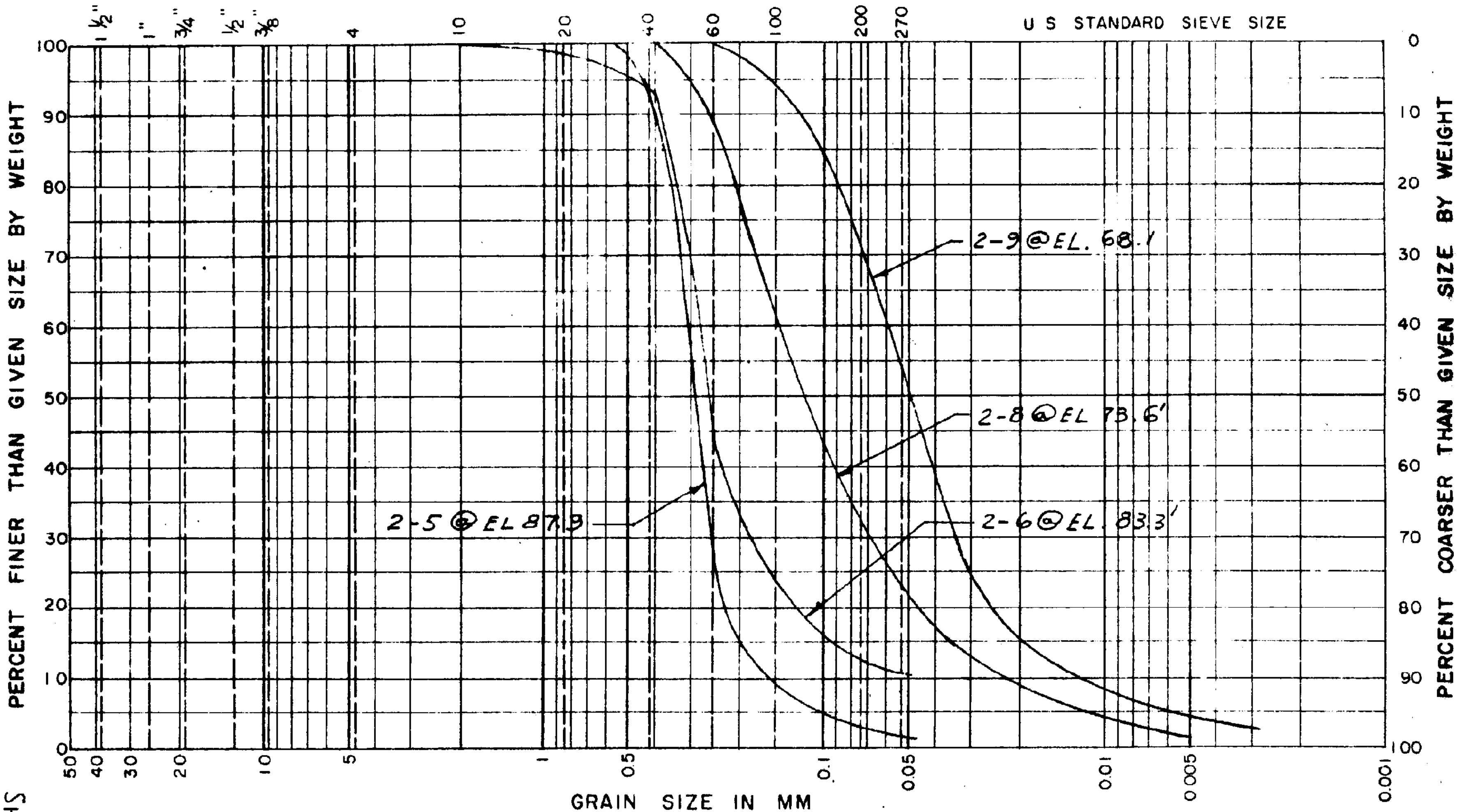
SEA419368

## METROPOLITAN ENGINEERS

JOB NO. W210B LOCATION ______ DATE SAMPLED ______ BY ______

BORING 2 DEPTH ______ ELEVATION ______ DATE TESTED ______ BY ______

SOIL CLASSIFICATION ______



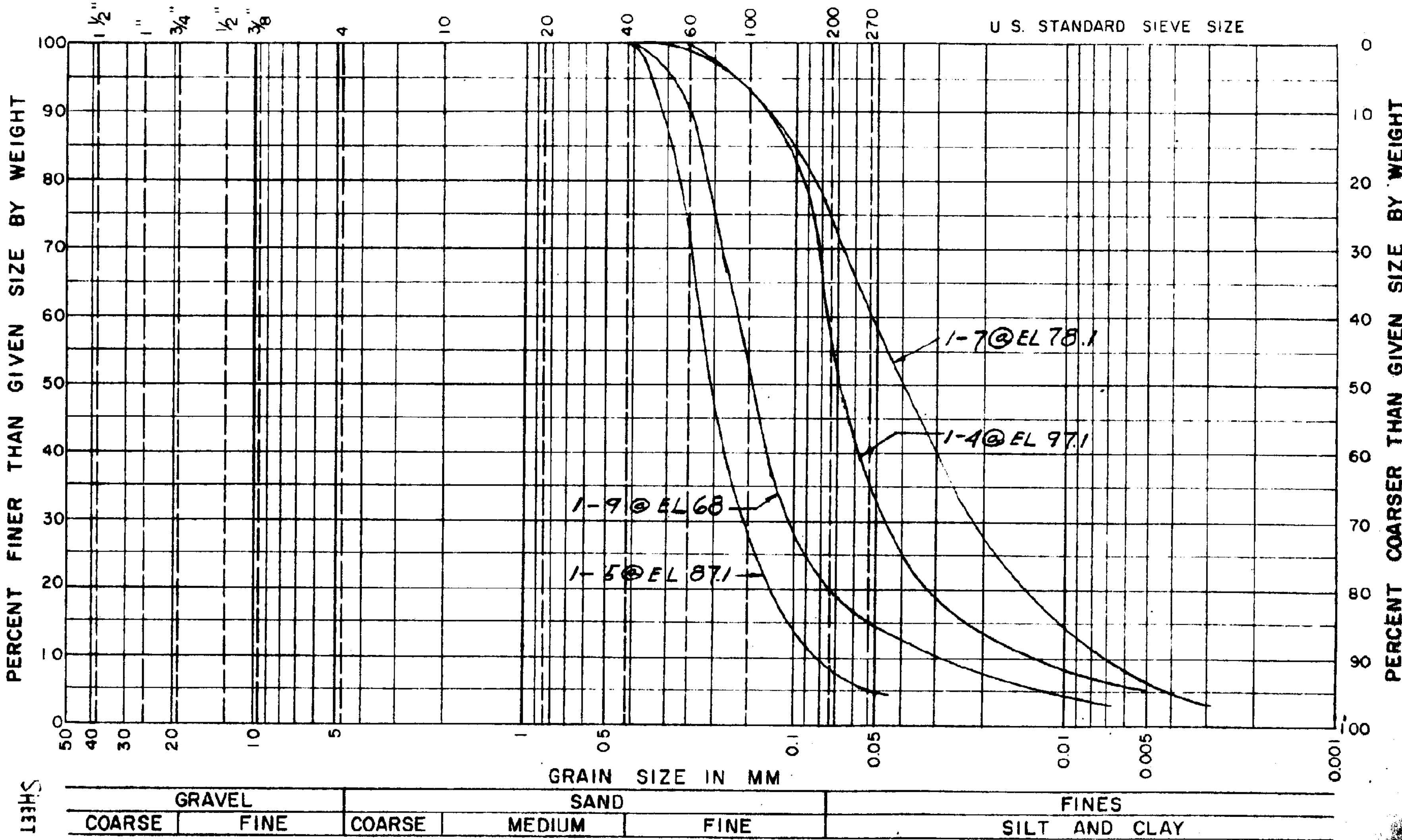

## GRAIN-SIZE DISTRIBUTION

SHEET No. 7

KCSlip4 53009

METROPOLITAN ENGINEERS

JOB NO. W210 B LOCATION ______ DATE SAMPLED ______ BY ______
BORING 1 DEPTH ______ ELEVATION ______ DATE TESTED ______ BY ______
SOIL CLASSIFICATION ______




# GRAIN-SIZE DISTRIBUTION

SHEET No.6

KCSlip4 53010

SEA419370